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On the Principles which regulate the Incidence of  
Taxes

By Professor Fleeming Jenkin, 1872.

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This essay is primarily known for presenting an early (possibly the first) version of the geometrical "proof" regarding the deadweight loss (or "excess of loss" as Jenkins called it) associated with taxation of goods.

## 3. On the Principles which regulate the Incidence of Taxes.

By Professor Fleeming Jenkin.

It is well known that many taxes do not fall ultimately on the person from whom they are in the first instance levied. The merchant advances the duties imposed on goods, but the tax ultimately falls on the consumer. The problem of discovering the ultimate or true incidence of each tax is one of great importance, and of considerable complexity. The following paper contains an investigation of the methods by which this incidence may in some cases be experimentally determined, and of the principles regulating the incidence in all cases, these principles being stated in a mathematical form.

The author, in a paper published in *Recess Studies*, expressed the law of supply and demand by representing what may be termed the demand and supply functions, as curves. The ordinates parallel to the axis OX, fig. 1, were prices—the coordinates parallel to the axis OY were the supplies at each price, and the demand at each price for the respective curves—the market price is then indicated by the ordinate X of the point at which the curves intersect, this being the only price at which buyers and sellers are agreed as to the quantity to be transferred.

We might write the law algebraically as follows, calling  $y$  the quantity of goods in the market, at each price  $x$ , we have  $y = \phi x$ ; and calling  $y_1$  the quantity of goods demanded at each price, we have  $y_1 = \phi_1 x$ ; the market price is determined by the equation  $y = y_1$ . There is, however, little or no advantage in adopting this algebraic form, because we cannot suppose that in any instance  $\phi x$  or  $\phi_1 x$  will be any tolerably simple algebraic function, whereas the curve for given goods might be determined experimentally by observing from year to year variations of quantities bought or quantities supplied at various prices.

Professor Jevons has since given a much more complex algebraic representation of the same law, which, however, reduces itself to the above simple form.

The graphic method may also be employed to indicate the advantage gained by each party in trade, and to show how it may be estimated in money. Let the two curves indicate the demand

and supply at each price for a certain kind of goods. If all sellers were of one mind, and were willing to supply all their goods at a given price  $x$ , and were quite determined to sell no goods below that price, the supply curve would be a mere straight line parallel to OX; and ending abruptly at the ordinate raised at  $x$ . Similarly, if all buyers were of one mind, and would only buy below a given price  $x$ , but were willing to buy all they want at that price, and no more at any lower price, the demand curve would be a line parallel to OX ending abruptly at the ordinate raised at  $x$ , and the price would be quite indeterminate. If the two lines overlapped, transactions might take place at any price between that at which the

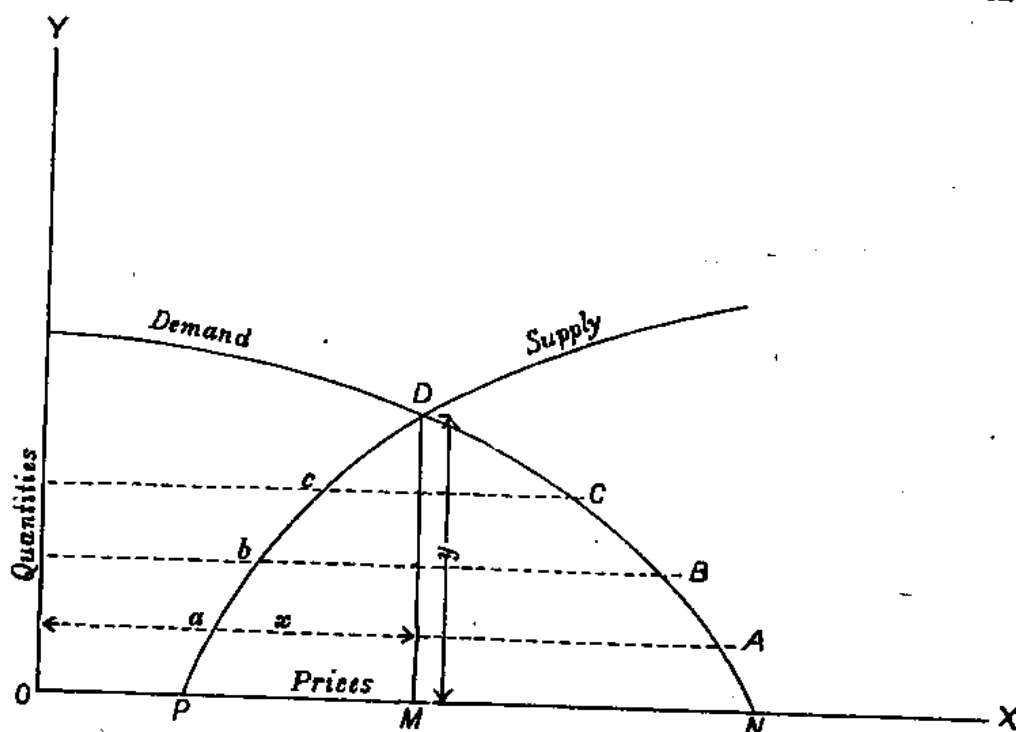


Fig. 1.

sellers were willing to sell and the buyers willing to buy; there would in this case be no market price. This case does not represent the true state of either buyers' or sellers' minds in any real large market. There are always a few holders who would only sell if the price were much higher than the market price,—these are the people who expect prices to rise; there are some who are just willing to sell at the market price, but who will not sell a penny below; and there are others, weak holders, who expect prices to fall, and these would really, if pushed to extremity, sell below the market price. This condition of things is represented by the supply curve in fig. 1.

Similarly, there are a few buyers who, if pushed to extremity, would buy some goods above market price; some also will just buy at market price; some will not buy unless the price is below market price. This is represented by the demand curve.

Now, I contend that when the market price is fixed, those traders who are perfectly indifferent whether they buy or sell at that price reap no benefit by the trade; but these will be few in number.

Looking at the demand curve, the ordinate  $X_1$  from the axis  $OY$  to  $A$  represents the value set on some of the goods by some buyers, but these buyers have got the goods for the sum represented by the ordinate  $x = OM$ ; the difference between these two ordinates  $X_1 - x$  is the difference in price between what was given and what might have been given for a certain small quantity  $\Delta y$  of goods.  $\Delta y$  is therefore the benefit reaped by buyers from the purchase of the quantity  $\Delta y$ ; and integrating the benefits derived from the sale of each successive quantity, we find the area  $MDCBAN$  represents the whole gain to buyers by the purchase of the quantity  $y$  of goods. Similarly, it is easy to show that the area  $MDcbaP$  represents the gain to sellers by the same transaction; these areas represent the gain in money. Each product  $\Delta y(x - X_1)$  being the product of a quantity by the gain in money per unit of quantity.

Thus the whole benefit to the two leading communities is represented by the sum of the two above named areas, and the repartition of the benefit between the two communities is perfectly definite.

Professor Jevons has used curves to integrate what he terms the utility gained by exchange in a manner analogous to the above; but utility, as he defines it, admits of no practical measurement, and he bases his curve, not on the varying estimates of value set by different individuals each on what he has or what he wants, but on the varying utility to each individual of each increment of goods. The above estimate of the gain due to trade, deduced from the demand and supply curves as originally drawn in my *Recess Studies* article is, I believe, novel, and gives a numerical estimate in money of the value of any given trade, which might be approximately determined by observing the effect of a change of prices on the trade; the curves throughout their whole lengths could cer-

tainly not, in most cases, be determined by experiment, but statistics gathered through a few years would show approximately the steepness of each curve near the market price, and this is the most important information.

A steep supply curve and a horizontal demand curve indicate that the buyers reap the chief benefit of the *trade*. The sellers, if producers, may, however, be making important profits as capitalists and labourers.

A steep demand curve and a level supply curve indicate that the suppliers are chiefly benefited by the trade; the community or body which is most ready to abandon the trade if the price increases a little, benefits least by the trade.

When the traders are producers and consumers, the benefits estimated in this way as due to the *trade* are not the only benefits reaped by the community from the manufacture.

In this case, what is termed the supply curve depends on the cost of production of the article, including that interest on capital and that remuneration for skilled superintendence which is necessary to induce the producer to employ his capital and skill in that way. The cost of production increases generally with the quantity of the article produced, otherwise the supply curve would be a straight vertical line; but as a matter of fact, to produce an increase of production a rise of price is necessary, indicating that only a few men with little capital are content with a small rate of interest and small remuneration for their skill, but that to induce many men and much capital to be employed in the particular manufacture, a large rate of interest and considerable remuneration are required, hence the supply curve will be such as shown in fig. 2, where the price  $OP$  is that price or cost of production which is just sufficient to tempt a few producers to produce a little of the article.

Then if  $OP'$  is the actual cost out of pocket required to produce a small quantity of an article, and if  $OP$  is the lowest cost at which any manufacturer can afford to produce it, the area  $P'DDM$  represents the whole profit to the producing capitalist when the price is  $OM$ . The line  $D'P'$  is not necessarily parallel to  $DP$ , nor vertical, the bare cost of production of the article generally increases as the quantity increases; and in that case  $D'P'$  is not vertical. Again, the rate of interest required to tempt additional capital

into a particular field is not constant, but increases, hence  $P'D'$  is steeper than  $PD$ . I see at present no means of experimentally ascertaining the gain reaped by producers represented by the area  $PDD'P'$ ; it can be approximately estimated by considering the prevailing rate of interest in the producing community and the amount of capital required for the production of the unit of the article.

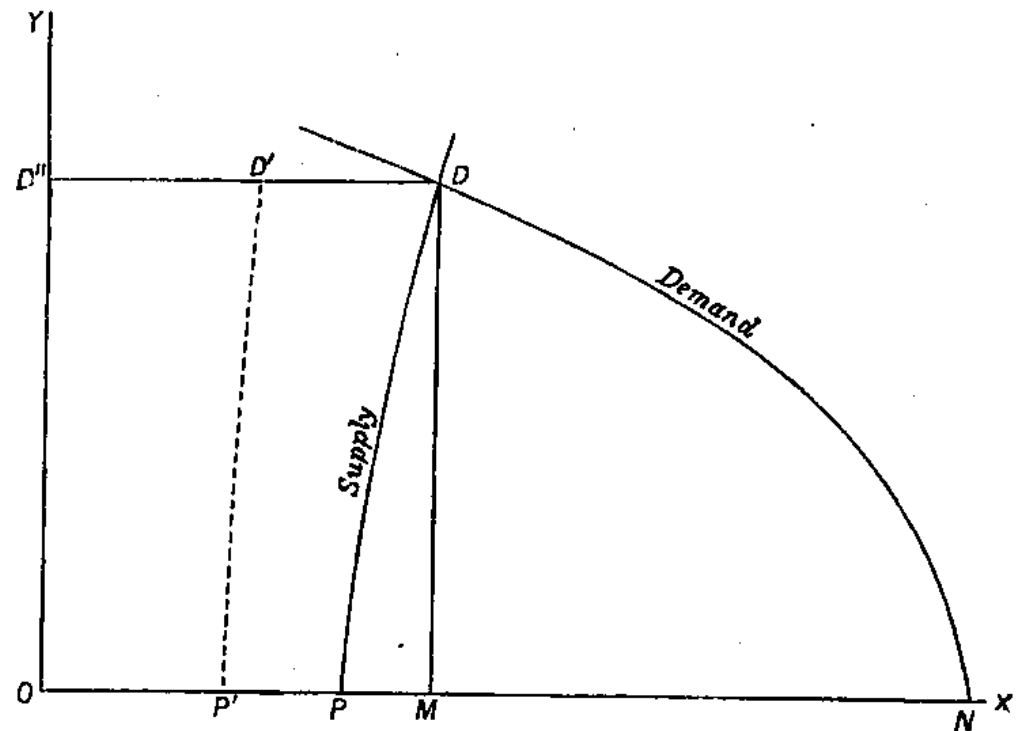


Fig. 2.

We see that the gain of a manufacturing capitalist may be divided into two parts—the profit as a trader, and the interest as a capitalist.

In safe trades, where there are few fluctuations in price, the former gain may perhaps be the most important; in more speculative trades the latter.

There is yet a third source of gain to the manufacturing community: the labourer who produces the goods earns his wages by the manufacture, and this is an advantage to him. In the diagram, the area  $OP'D'D''$  represents the wages paid for labour alone. The length of the lines between  $OY$  and  $P'D'$  represent the wages of labour per unit of goods, increasing as the quantity of goods required increases. This is lost to the community if the manufacture is stopped. Thus the whole sum paid by the consumer is the area  $OMDD''$ ; and this is made up of three parts, one of which

is the profit to the trader, one the interest to the capitalist, and one the wages of the labourer; all these advantages are lost if the manufacture ceases.

The gain of the labourer does not resemble the profit of the trader, or the interest of the capitalist. The profit of the trader is the difference between his valuation of the goods and what he gets for them. If he does not sell his goods he still has his goods, he only loses the profit. Similarly, if the capitalist does not sell his capital, he still has his capital. Now, the area  $P'PDE'$  represents the profit made by the capitalist on the particular employment of his capital, and this is all that he loses if unable to sell that capital; but the area  $OP'D'D'$  represents the whole sum received by the labourers, not their profit. The profit of the labourer may perhaps be considered as the excess of wages which he earns in a particular trade, over that which would just tempt him to work rather than starve or go into the workhouse.

If the consumer purchases the article for simple unproductive consumption, then the loss to him is only represented by the area  $DMN$ . If, however, a community purchases goods, and consumes them productively, then, by the cessation of the trade, they in their turn lose the interest on the capital they employ, and the labourers of the community lose their wages; so that, in that case, the loss to the buyer, who cannot be classed as an immediate consumer, is made up of three parts, similar to those enumerated in the case of the seller.

#### *Taxes on Trade.*

Having distinguished between the three distinct advantages given by trade, I will now consider the incidence of a tax on trade, levied as a fixed sum per unit of goods, as one pound per ton, or one shilling per gross.

The effect of such a tax is to produce a constant difference between the price paid by the buyer and the price received by the seller. The market prices are determined in the diagram of the supply and demand curves, by the points between which a line parallel to  $OX$ , and equal in length to the tax, can be filled between the two curves.

Thus, if in figure 3,  $FN$  be the demand curve, and  $PE$  the supply curve, and if the length of the line  $CC'$  be the amount of

the tax per unit of goods, then  $OM$  is the market price to the supplier,  $OM'$  the market price to the buyer and the difference  $Mm'$  is equal to the tax.

The total amount raised by the tax from the transactions represented in the diagram, is measured by the area  $MCC'M'$ . The

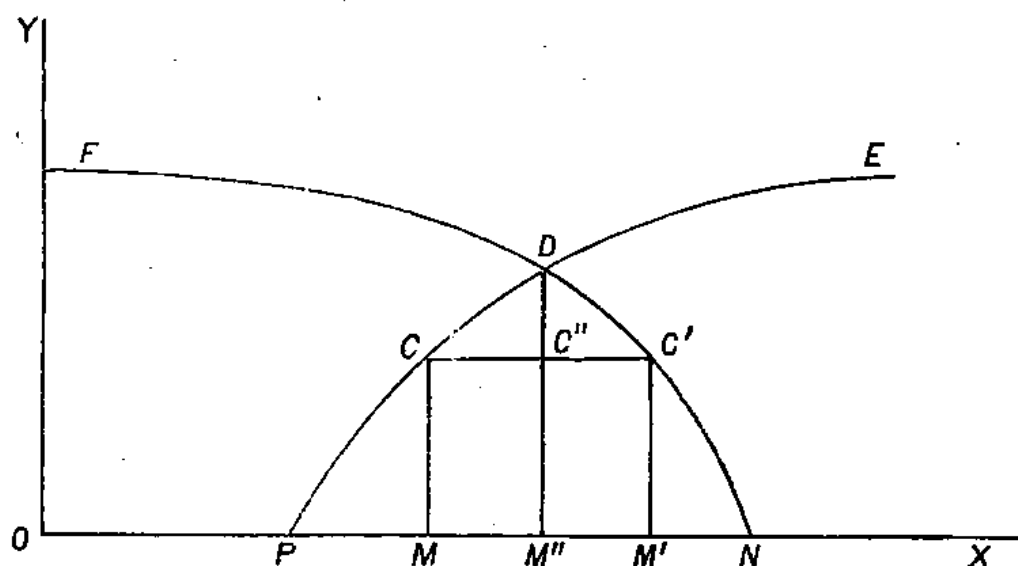


Fig. 8.

portion paid by the seller is measured by the area  $CC''M''M$ . The portion paid by the buyer is measured by the area  $C''C'M'M'$ . The whole loss entailed by the tax on the two communities is measured by the area  $MCDC'M'$ ; the loss to the sellers is measured by the area  $CDM''M$ ; the loss to the buyers by the area  $M''DC'M'$ ; both buyers and sellers suffer a loss beyond the tax they pay. This excess of loss is represented by the area  $CC''D$  for the sellers, and  $C'C''D$  for the buyers.

If the tax be large, the line  $CC'$  will approach the axis  $OX$ , the tax will be unproductive, and the area  $CC'D$  representing the excess of injury to the buyers and sellers will be large, compared with the produce of the tax. This fact is one justification of free trade.

There is a certain magnitude of tax which will produce the maximum revenue or value for the area  $MCC'M'$ . The ratio in which the tax falls, in one sense, on sellers and buyers is simply the ratio of the diminution of price obtained by the sellers to the increase of price paid by the buyers.

It is absolutely clear that this is the proportion in which the tax is actually *paid* by the two parties, although this may by no means



correspond to the relative suffering inflicted on the two parties, nor is it even the proportion in which the two parties lose by the loss of trade profit. The whole loss of either party is, as the diagram shows, always greater than the tax they pay. The relative total losses of the two communities as traders, are in proportion to the areas  $MCDM''$  and  $M'C'DM''$ ; and these areas might approximately, at least, be ascertained by experiments for this purpose, treating  $CD$  and  $C_1D$  as straight lines, we only require to know the quantity and price of the goods before the imposition of the tax, and the quantity and price afterwards.

Thus, if a tax of 2d. per pound were imposed on the trade in cotton between ourselves and America, if before the tax we imported 500 million lbs. at one shilling, and after the tax 300 million lbs. for which we paid  $13\frac{1}{2}$ d., and the Americans received  $11\frac{1}{2}$ d., the total loss to the two communities as traders would be  $600 + 200 = 800$  million pennies, the produce of the tax 600 million pennies.

England would pay of the tax 450 million pennies. England's total loss would be 600 million pennies. America would pay of the tax 150 million pennies. America's total loss would be 200 million pennies. The incidence would be the same whichever government levied the tax.

It follows from the above principles, that if a holder sells unreservedly, trusting to the competition between the buyers to produce the market, the whole tax falls on the seller; the supply curve becomes a vertical straight line. If a buyer buys unreservedly, the whole tax falls on him; in this case the demand curve becomes a vertical straight line.

Thus, if sales by auction were subject to a tax *ad valorem* or otherwise, and if sales were quite unreserved, the number of transactions not being altered, the prices would be unaltered, but the sellers would only get the prices minus the tax.

This case does not practically arise, because, if auctions were really so taxed, although in each auction that occurred the sale might be unreserved, auctions would, as a whole, be checked; fewer people would put up their goods for sale in that way,—the prices would rise, the number of transactions would be diminished, and the tax would really be borne in part by the buyers and part by the sellers.

If the trade between two countries really consists in the exchange of goods, effected by the agency of money as a unit for expressing value, but not involving the actual transfer of coin, the above principles show the whole gain by the exchange to be the sum of two gains which each party would make by each trade if it alone existed.

If by duties one portion of the trade be extinguished or much diminished, both parties lose, but if the other portion of the trade remain uninjured, then, although there may be no exchange of commodities other than of goods for actual money, nevertheless the full gain on that which is untaxed remains intact. Thus, although the French may tax our goods, and so inflict a loss on themselves and on us, this is no reason for our inflicting an additional loss on the two communities by taxing the import of their goods.

#### *House Rent.*

I will next consider the effect of a tax on house rent.

Landlords are here the sellers, and tenants the buyers of what may be termed a commodity; not the house, but the loan of a house for a term of years—the tenant buys what might be called, by the extension of a suggestion of Professor Jevons, a *house-year* from his landlord.

The difference between the house and other commodities such as food or dress is, that the house remains, whereas they are consumed. The house-year is consumed year by year, but it is reproduced year by year without material fresh expenditure on the part of the landlord. This permanency alters the incidence of taxation.

If the demand falls off the landlord cannot remove his house—he cannot cease to produce his house-year, which therefore he must dispose of. Hence, in a stationary or declining community, where no new houses are being built, but where year after year a sensible proportion remains unoccupied, the landlord must sell his house-year unreservedly, and any tax imposed on house rent would fall on him alone; that is to say, he would receive a rent diminished by the full amount of the tax, and the tenant would pay no more rent for a house of a given class than if no tax were imposed. The supply curve becomes a straight horizontal line, and is unaffected by the tax; the demand curve is equally unaffected by

the tax; the number of houses let is unaltered by the tax, but the landlords lose as rent the whole amount raised by taxation.

This reasoning is based on the assumption, that the supply curve has become a straight horizontal line unaffected by the tax. This condition is altered in any prosperous or growing community. There, new houses must be built, and a considerable number of houses are always unlet, not because they are not required by the community, but because the speculative builders are holding out for higher terms. This produces a supply curve of the kind common to all other kinds of goods. At higher prices more goods are forthcoming. A newly imposed tax will then be distributed between sellers and buyers, landlords and tenants in a manner depending on the form of these curves. A sensible check will be given to the letting of houses, tenants will be content with somewhat less good houses, and landlords with rather smaller rents. This is the immediate effect of the tax—the greater portion would probably fall on the landlords at first, at least in the new houses where fresh contracts are being made. But after a few years the conditions would have altered. New houses are only built because the builders obtain the usual trade profit and interest on their capital—the check to letting consequent on the imposition of the tax will therefore diminish the supply of new houses until, owing to diminution in supply, rents have risen to their old average. Then builders resume their operations. The whole tax by that time will be borne by the tenants; that is to say, if there were no tax they would get their houses cheaper by the precise amount of the tax, because rents so diminished would suffice to induce speculative builders to supply them. The rents through the whole town are ruled by those of the new districts. There is a certain relative value between every house in the town, and if the rents of new houses are dearer the rents of the old houses are increased in due proportion. In fact, when new houses need to be supplied year by year, houses are commodities which are being produced, and the tax falls on the consumers.

The above principles determine the incidence of a tax, whether nominally levied on the landlord or tenant, but in their application account must be taken of the mental inertia of both landlords and tenants, as well as of the fact that many contracts for houses are

not immediately terminable. These two conditions will for the first few years after the imposition of any new tax cause it to fall on the party from whom it is nominally levied.

Precisely as a tax on trade not only falls on the traders, but injures capitalists and labourers, a tax on house rents injures the capitalists who build houses and the labourers they employ—not that the capitalist pays the tax, but he is prevented from finding a useful investment for his money owing to the diminution in the number or quality of houses required.

#### *Taxes on Land.*

The question of the incidence of taxes on land is peculiarly interesting. Land differs from all other commodities, inasmuch as the quantity of it does not depend on the will of any producer. The number of houses in a flourishing community does depend on the will of speculative builders; but land can only be increased in quantity by such processes as enclosing commons, or breaking up private pleasure grounds. We will neglect these small disturbing influences, and assume that all the land in a country is available for cultivation, where such cultivation is profitable; and that the absence of profit is the only reason for neglecting to cultivate any portion of it.

It is well known that the rent of each acre of land is simply the excess of annual value of that acre over the annual value of the poorest land which tenants think it worth while to cultivate. We may classify all land according to the total return which it will yield per acre upon capital invested in its cultivation; and we may draw a supply curve of land such that the ordinates will be the total quantities of land which will return each successive percentage on the capital required to cultivate it. The supply diminishes as the rate of percentage increases, that is to say, there is less land which will return ten per cent. on the capital than will return five per cent., and still less land which will return twenty or thirty per cent.

If, therefore, tenants as a body, considered as capitalists, will not cultivate any land which does not yield twenty per cent., there will be far less land in the market than if they will be just satisfied with ten per cent.

Again, all tenants are not of one mind, and we may construct a demand curve in which the ordinates are the total quantities of

land which would be let, if the land paying no rent be fixed at each successive percentage. The actual quantity of land let will be determined by the intersection of the two curves, and is represented by the height MD, fig. 4.

If we now build a solid on the base OD'DN, such that its height all along each ordinate  $x$  is the number of hundreds of pounds of capital per acre required to give the percentage corresponding to the length  $x$ , then we shall have a volume standing on (OD'DN), the contents of which will measure the total annual returns from all the land cultivated.\* The rent is the volume standing on MDN, the profit received by the farmers is the volume standing on OD'DM, and this is in excess of what would have just tempted them to cultivate by the volume MDP. We may, therefore, considering the farmer as a capitalist and a trader, call the volume on MDP his trade profit, and the volume on OD'D, the interest on his capital.

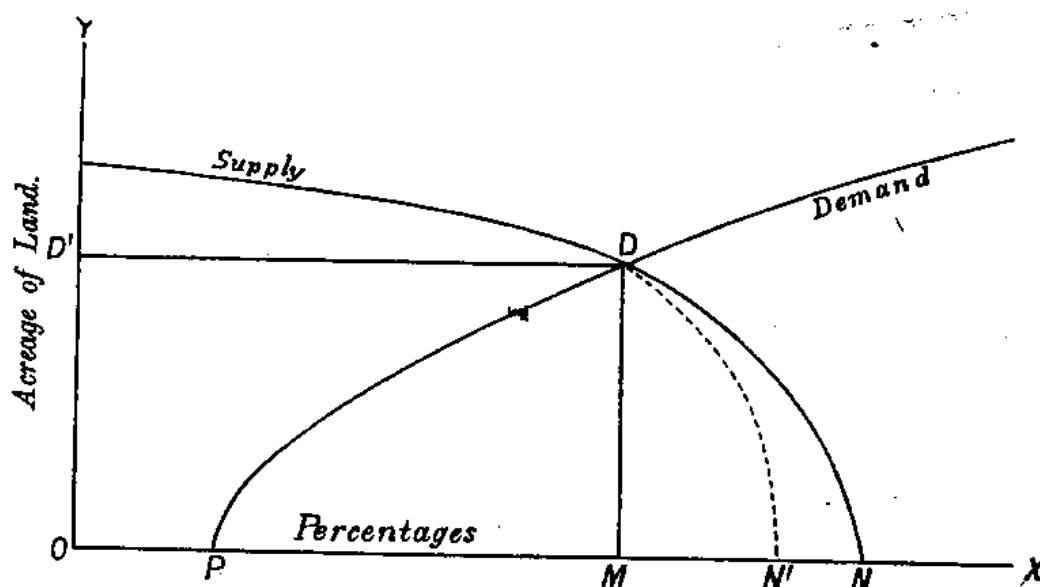


Fig. 4.

The effect of any tax on the land is to reduce the interest which each class of land is capable of returning on the capital employed. This it will do in very different ways according to the manner in which the tax is levied.

\* If £150 per acre are required to give the percentage  $x$  of any one class of goods, the height of the ordinate perpendicular to the plane of OD'DN will be 1.5.

If the tax be an *ad valorem* duty on rent, it will modify the supply curve only between D and N. There will remain just as much land as before capable of paying rates of interest less than OM, but the quantity of land capable of paying the higher rates will be diminished; in other words, the rate of interest which the poorest land worth cultivating pays will not be affected, for this land pays no rent and remains untaxed—hence no land will be thrown out of cultivation, but the supply curve will be altered from DN to DN', diminishing the volume representing rent, but leaving the other quantities untouched; hence any tax assessed on rent is paid wholly by the landlord. The amount of the tax is the volume standing on DNN'. It is curious to remark that this tax in no way falls on the consumer. The tax on rent simply diminishes the excess of value which some land has over others; no land is thrown out of cultivation, and no less capital employed in production than before; no one suffers but the landlord. If, instead of being assessed on the rent, the tax is assessed on the produce of the cultivation, the incidence of the tax will be greatly modified. The cultivation of land will no longer be so profitable; i.e., the returns from capital employed on the land will be less; in other words, the whole supply curve of the land will be modified, falling everywhere if the produce taxed be that which is produced on all qualities of land. Some land will fall out of cultivation, and only part of the tax will be borne by the landlord; part will fall in the first instance on the tenant, but he, like any other manufacturer, will recover almost the whole of his portion from the consumer. Tenants will be injured by the limitation of the number of transactions, and labourers by the diminution in the amount of work required. This is the effect of an octroi duty.

Sometimes a tax is assessed not on the rent, but on an assumed value per acre. Such a tax can never be raised on land which pays no rent, for the owner would rather abandon possession of the land than pay the tax. It might, however, lead to the abandonment of the cultivation of poorer soils; it would then injure tenants and consumers, although they would not pay one penny of the tax; for taxes cannot be paid out of lands which lie waste; assuming that the tax is always less than the rent, as it certainly always should

be, it will be paid wholly by the landlords. The tax in this case does not diminish the supply of land.

A cognate question of great interest is, Who reaps the benefit of any improvements in agriculture, making land return more than it previously did? This improvement may require, and probably will require, increased investment of capital. The whole supply curve will be raised; assuming the demand to remain the same, fig. 5,  $M''D''$  will be the new increased number of acres in cultivation, but land will be left uncultivated which would have returned the interest  $OM$  on capital. The volume standing on  $D'D''N''$  will be much greater than that on  $D'DN$ , for the third dimension will also have increased; the average rate of interest and the trade profit of the tenant will have increased, and it is highly probable that the volume standing on  $D''M''N''$  may be greater than that which stood on  $DNM$ ; but this is by no means certain. It might at first be actually smaller. In all probability, however, the demand curve is very nearly vertical, a small increase of profit tempting a

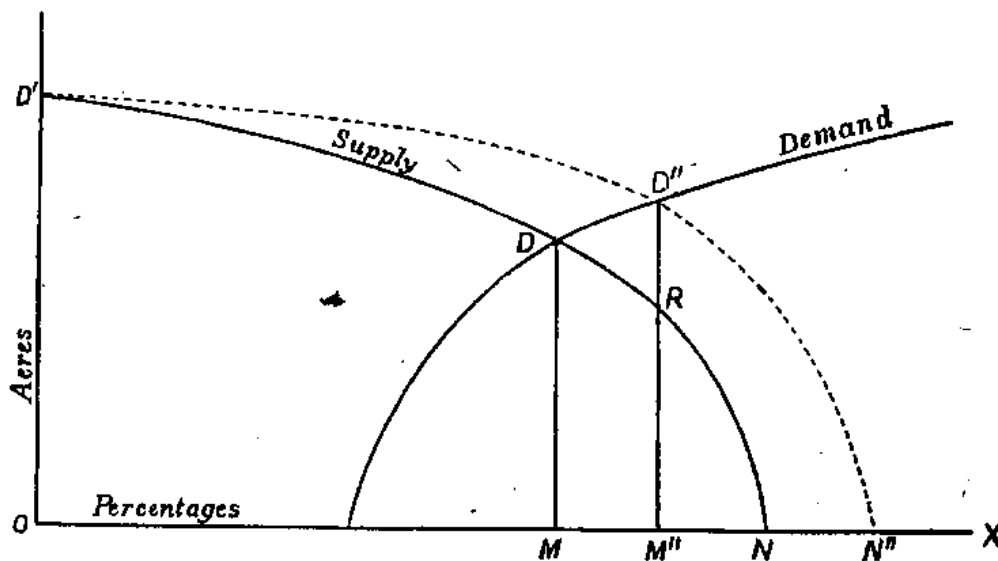


Fig. 5.

largely increased investment of capital in farming. If this be so, then the landlord also reaps considerable benefit from the improvement, for if the farmers were contented with nearly the same rate of interest as before, the solid standing on  $DRNN''D''$  which he gains would be larger than the solid on  $DRM''M$  which he loses; moreover, the volume on  $RNM''$ , which he retains, is increased. Labourers and consumers also gain.